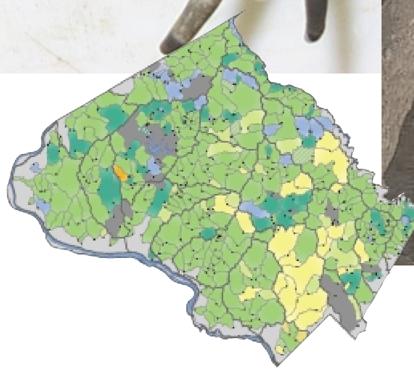
Countywide Stream Protection Strategy

2003 Update

This update of the Countywide Stream Protection Strategy provides information on the current status of county stream conditions based on the first five year watershed monitoring cycle completed in 2000.

STREAM QUALITY CONDITIONS
1994-2000



CURRENT HABITAT STATUS
1994-2000

M O N T G O M E R Y   C O U N T Y ,   M A R Y L A N D

Countywide Stream Protection Strategy

2003 Update

Updates: Each year DEP monitors different watersheds as part of the baseline monitoring program. Our stream data is continually updated as new information becomes available. For the latest information please go to **updates.askdep.com.**

Department of Environmental Protection
Montgomery County, Maryland

Table of Contents

From the County Executive

This 2003 Countywide Stream Protection Strategy (CSPS) report is a testament to the County's commitment to improving environmental quality on an on-going basis.

This is not a report that is produced with much fanfare and then sits on a shelf. The CSPS evaluation is an active, vibrant, process that is continually updated to give us the most current assessment of the county's water quality. And, it is a critical decision-making tool that allows us to target our resources to the projects that are most effective in improving stream quality.

In 1998, Montgomery County made a commitment to assess the condition of about 1,500 miles of streams through an innovative method that evaluates not only water quality, but the diversity and quality of biological life and stream habitat. Now, five years later, our comprehensive approach, conducted with the cooperation of many agencies and volunteers, has provided the County with data to establish and assess watershed management priorities.

I invite all the citizens and businesses in Montgomery County to use this CSPS report to learn more about environmental conditions and to become more actively involved with programs and opportunities which protect and restore the quality of our shared environment.

Douglas M. Duncan
Montgomery County Executive

From the DEP Director

The Department of Environmental Protection is pleased to release this update to Montgomery County's 1998 Countywide Stream Protection Strategy (CSPS). The following document reflects the first in a much-anticipated series of updates to DEP strategic plans. The initial success of the CSPS as a technical report and management tool was responsible for shaping the County's subsequent development of a Countywide Forest Preservation Strategy (October 2000), Groundwater Protection Strategy (October 2001) and Air Quality Strategy (November 2003). The CSPS and these other management strategies are receiving recognition nationally as models for other communities to follow. DEP is proud of its role as a leader in developing meaningful strategies which serve to effectively direct future efforts in support of our mission to protect and restore our natural resources.

James A. Caldwell
Director, Department of Environmental Protection

I. Executive Summary

Background

In February 1998, the Montgomery County Department of Environmental Protection (DEP) completed an assessment of biological, chemical, and habitat conditions covering most of the streams within county boundaries. The resulting *Countywide Stream Protection Strategy* (CSPS) evaluated stream conditions based upon aquatic life and stream channel habitat indicators in addition to typically applied stream chemistry measurements. This report updates the CSPS to replace preliminary data used in the original evaluation for some county streams. It provides a comprehensive picture of stream conditions observed between 1994 and 2000. Further, it documents the progress the County is making in addressing watershed management priorities originally identified in the CSPS.

TABLE 1A. 1994-2000 County Stream Conditions

Stream Condition	Stream Miles	Percent of Streams Monitored
Excellent	84	7
Good	694	55
Fair	362	28
Poor	131	10
Total Monitored	**1272**	**100**
Waters Not Monitored	226 (see Table 5A)	
Total	**1498**	

Resource conditions in county streams

Citizen understanding and interest in stream quality is enhanced when results focus on the living organisms found in their neighborhood streams. The CSPS uses familiar terms to discuss the presence, absence, and diversity of fish and aquatic insect populations in a given stream, and the quality of the supporting stream habitat, such as adequacy of riffles, pools, stream side tree cover, and vegetated buffers. Across the county, 60 species of fish and about 420 types of aquatic insects were found. While many streams supported diverse and vibrant aquatic communities, others have impaired habitat conditions which support fewer species at reduced populations. Table 1A updates information on countywide stream conditions, based upon final results from biological monitoring conducted during 1994-2000.

These results show that 62 percent of monitored county streams are rated as being in good to excellent condition, with 38 percent in fair or poor condition. The report also updates original CSPS findings on the quality of stream habitat, including separate ratings on the stability of the stream channels. Some limited data on trends observed in county streams is also presented, based upon a statistical evaluation of results from those stations that have been sampled at least twice. trends.askdep.com

Compliance with water quality standards

Although the extent and diversity of biological life and habitat conditions vary widely, nearly all county streams meet Maryland water quality standards and criteria for dissolved oxygen, temperature, and pH (COMAR 26.08.02.03-3), as they have historically. However, limited samples of *nutrient concentrations* show county streams exceed levels needed to reach voluntary nutrient reduction targets established to address Chesapeake Bay management needs. As in most places nationally, bacterial standards are also violated in county streams, which reflects contamination from a diverse variety of natural and man-made sources, including wild mammal and bird populations, pets, leaks or overflows from aging sewer lines, and septic tank overflows. Most violations occur following runoff from storm events. DEP continues to focus its efforts toward improving control of those sources considered most manageable.

Primary causes of biological impacts

Stream erosion and sedimentation remain the dominant impacts on county stream habitat conditions and aquatic life. Some river systems are still adjusting to impacts of "legacy sediments" introduced from past centuries when watersheds were first converted from primarily forested to agricultural uses. Over the past 50 years or so, the county's population growth and development gradually shifted many primarily agricultural watersheds into urban and suburban communities. Uncontrolled or inadequately controlled stormwater runoff accompanying these latest watershed changes has significantly altered natural stream flows and increased erosion, impacting stream habitat and resident biological communities. Inadequate management of construction sites contributed a few localized sediment "hot spots." There are also isolated instances where other pollutant sources, such as pesticide spills, were a primary cause of biological impairment. In 1999 the county experienced severe drought conditions which markedly reduced stream flows, particularly during the summer when rainfall and groundwater reached historically low levels that cut off replenishment of many stream systems. Upper headwaters of many small streams became segmented or dried up entirely, which severely impacted some resident aquatic life and limited DEP's ability to carry out planned monitoring activities.

Nature of impaired subwatersheds

The most severely impaired streams are generally found in the older, "down-county" areas. Development at urban and suburban densities occurred here years before stormwater controls were required to help mitigate impacts of accompanying increases in peak stormwater runoff flows and associated pollutant concentrations. Outmoded land development practices at the time regularly enclosed small headwater streams and springs with stormdrain pipes and filled in, rather than preserved, natural wetlands. Biological impairment was also found in some predominately agricultural subwatersheds, suggesting a need for voluntary implementation of additional agricultural *best management practices (BMPs)*.

Relationships of impacts to impervious areas

The severity of stream habitat degradation and biological impairment seen in county streams can be generally related to the extent that forests, natural vegetation, and underlying topsoil has been graded away and replaced with hard or highly compacted urban land surfaces such as roads, parking areas, buildings and surrounding lawn areas. These relatively impervious surfaces inhibit the natural *infiltration* g of rainfall, causing significant increases in stormwater runoff and corresponding reductions in the natural replenishment of groundwater. Increased stormwater flows and reduced groundwater replenishment both adversely affect natural stream *hydrology* g and stream habitat. DEP has begun to further analyze these relationships by comparing observed stream quality to drainage area information on land use, impervious area, lawn areas, tree canopy, and protected stream buffer areas. This report further discusses some of these analyses.

Effectiveness of stormwater controls

In general, modern and well-maintained on-site stormwater controls appear to have positive effects in mitigating, but certainly not eliminating, the impacts of increased stormwater runoff from developed land surfaces. However, scientific data currently available on the actual effectiveness of various types of urban BMPs is surprisingly limited. DEP is assembling more complete information to compare stream conditions in small watersheds protected by modern stormwater controls to conditions found in other watersheds that have similar levels of development, but lack modern stormwater controls. The County is also pursuing pilot projects to integrate more on-site Low Impact Development (LID) design principles and technologies, such as rain gardens and rain barrels, into the mix of stormwater controls used to reduce stormwater impacts.

Mitigating new development impacts

The original CSPS provided an improved level of information on county stream conditions and management priorities which regulatory agencies employ as land use master plans are updated and subdivision, site design, stormwater management, and sediment control requirements are determined through permitting processes. The inspection, enforcement, and maintenance of construction site sediment controls have improved, but further progress appears needed. Stormwater controls have seen improved design standards and use new technology applications, including green roofs and bioretention, to reduce the generation of runoff requiring management. Increased application of innovative stormwater control measures will be needed to continue progress in reducing new development and redevelopment impacts on streams. Regulatory agencies should also seek ways to further reduce natural vegetation and topsoil losses and increases in impervious or compacted land surfaces that result from current land development standards for subdivisions, roads and sidewalks, utilities, parking lots, and individual buildings.

Watershed restoration priorities and progress

The original CSPS designated priority watersheds and identified watershed management categories and related management tools to guide interagency watershed restoration initiatives. DEP and partner agencies continue to use this information to help target available resources for watershed restoration. Interagency efforts are aggressively pursuing proactive watershed restoration projects to mitigate impacts of previously uncontrolled runoff and restore stream habitat to support more diverse biological communities and natural stream settings. There has been substantial progress in completing watershed assessments and designing and constructing projects that help restore conditions in degraded urban watersheds. This includes: completion of watershed feasibility planning assessments for the Upper Paint Branch, Northwest Branch, Rock Creek, Cabin John Creek and the Hawlings River; construction of new stormwater controls to manage runoff from over three square miles of previously developed area; and restoration of habitat and erosion for over twelve miles of degraded streams.

Additional information on previous CSPS findings, watershed management categories, priority watersheds, and methods the County uses to evaluate stream conditions can be found in the original CSPS document. csps.askdep.com

Next steps

County agencies continue to work collaboratively on a variety of activities to sustain progress in implementing the CSPS. Goals and action items describing these activities are presented in this update. A few key planned activities include:

* Complete watershed studies now underway for the Lower Paint Branch and Watts Branch watersheds; initiate new watershed studies for the Great Seneca and Muddy Branch watersheds; design and construct new stormwater controls to manage another three square miles of developed area; and restore another 14 miles of degraded streams.
* Seek increased funding to expand street sweeping/vacuuming to improve pollutant source reduction from highly trafficked areas. Implement a pilot project to install and test the effectiveness of runoff filtration devices established in stormdrain inlets in central business district areas.
* Review current zoning, subdivision, building code and road code requirements to explore opportunities for implementing improved standards more consistent with water resource protection objectives to reduce generation of runoff and increase rainfall *infiltration* g for groundwater replenishment.
* Improve interagency efforts to address issues of encroachment on stream buffers, invasive species and excessive *deer browse* g problems, and dumping of trash and yard wastes all of which impact stream systems.
* Seek state legislation for a user charge/fee on nitrogen-based, urban lawn, and garden fertilizers to discourage excess use. Use collected revenues to fund outreach efforts to help reduce nutrient inputs to waterways.
* Complete monitoring to develop an *index of biological integrity* g for nesting birds and amphibians to help augment information developed for the County's next environmental assessment report.

II. Summary of Principal CSPS Findings, Uses, Accomplishments

Discussion of principal findings

The current update has examined results of CSPS monitoring data in conjunction with information on watershed land use, impervious areas, and other natural resource information available through the County's geographical information system. The monitoring data collected since 1998 contains complete datasets on fish, aquatic insect, and/or habitat conditions to replace most of the "preliminary data" classifications assigned to some subwatersheds in the original 1998 CSPS report. The only areas in the county without a stream condition rating are those without a perennial stream draining them, or areas too deep for crews to wade safely, enabling sampling of all pertinent parameters. The next complete CSPS update will be based upon results of data collected through DEP's current five-year watershed monitoring cycle, which ends in 2005. In the interim, DEP will periodically post stream monitoring data and related factsheets to disseminate more recent findings on its website. **reports.askdep.com**

The watershed management categories and priority subwatershed designations assigned in the original CSPS have been left unchanged inasmuch as overall relationships between stream condition and land use patterns have not changed sufficiently since 1998 to warrant extensive adjustments. The need for substantive change to watershed management categories or priority subwatersheds will be reviewed as part of the next CSPS update.

Ratings of stream conditions in most county watersheds (Figure 4B) did not change substantially from those derived in the original CSPS. Older, established urban areas generally have the poorest water quality and continue to reflect the impacts of outmoded practices that piped stream headwaters and/or lacked adequate stormwater management controls. Conversely, watersheds located in the more northern and western areas have a "good" or "excellent" stream condition rating. This apparently reflects a number of factors, including generally lower development densities and/or improved stormwater controls and stream buffers accompanying new developments, and the use of low or minimum till farming practices in the County's Agricultural Reserve.

Although there are no *nutrient concentration* standards that presently regulate county streams, limited monitoring data suggests relatively high nutrient levels in some of them. Slow moving bodies of water, such as the Patuxent reservoirs, have elevated nutrient levels. Delivery of nutrients downstream also remains a concern for the protection of the Chesapeake Bay. Bacterial contamination also continues to be a ubiquitous problem, both in county streams and nationally. Many wildlife sources of this contamination cannot be easily, if ever, managed. However, greater emphasis on inspection and repair of sanitary sewer infrastructure, enforcement of treated wastewater discharge permit requirement, and improving owner awareness of pet waste impacts are more manageable aspects of nutrient and bacterial sources which need to be better addressed.

CSPS uses and accomplishments

Montgomery County agencies apply the findings and priorities identified in the CSPS to focus watershed protection efforts in a variety of ways. The M-NCPPC uses these findings in considering environmental protection needs and impacts as it prepares and updates the County's land use master plans and, as it carries out development review and regulatory processes required for new subdivisions. M-NCPPC has also used CSPS findings and priorities to help identify land acquisition priorities under the Legacy Open Space Program and the Park Acquisition Program. CSPS results are considered by the Department of Permitting Services (DPS) in developing requirements for sediment control and stormwater management in the permitting process that regulates land development.

DEP uses CSPS monitoring results to support compliance with watershed assessment, project implementation, reporting, and enforcement requirements specified in the County's municipal National Pollution Discharge Elimination System (NPDES) stormwater discharge permit. Results are also applied to help assess and set project priorities for fulfilling voluntary regional commitments under the Anacostia Watershed Restoration Agreement, the Patuxent Reservoirs Watershed Agreement, and the Chesapeake Bay 2000 Agreement. DEP uses CSPS findings and priority subwatershed designations as it develops watershed studies and selects, designs, and constructs projects to improve runoff management and restore damaged streams in previously developed watersheds. The analytical approach used in the CSPS to characterize stream conditions and set management priorities contributes to DEP's success in securing cost-share grant funding for watershed restoration projects. DEP also applies CSPS results to help target its public outreach and water quality enforcement programs to focus on streams having the greatest protection needs. **priorities.askdep.com**

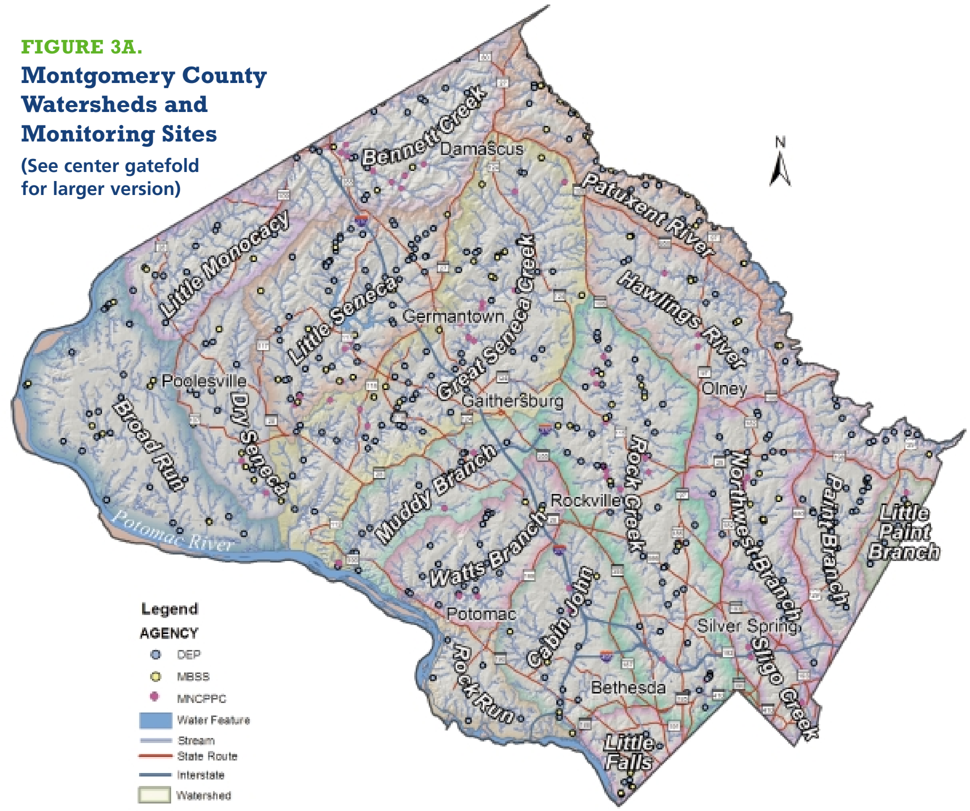
The CSPS has served as a stimulus for the County's subsequent development of a *Countywide Forest Preservation Strategy* (October 2000), *Groundwater Protection Strategy* (October 2001), and an *Air Quality Strategy* (November 2003). Actions being pursued to implement goals and action items identified in each of these strategies provide complementary cross-over environmental benefits that contribute both to air and water quality protection. All three of the adopted strategies received *Achievement Awards* from the National Association of Counties (1999, 2000, and 2001 respectively). In August 2002, the CSPS and the associated biological monitoring program and partnerships formed with other local and state agencies and volunteers also received recognition from the U.S. EPA as a national model for other communities to follow (U.S. EPA, 2002).

Collaboration on Monitoring Data Collection and Data Sharing

The County relies heavily on sustaining monitoring partnerships with public agencies and volunteer groups to promote efficient data sharing and analysis of water quality conditions in county streams. Key partners in this effort are the M-NCPPC and the Maryland Department of Natural Resources (DNR), including its Maryland Biological Stream Survey (MBSS). Monitoring by volunteers also provides important sources of supplemental information to the existing knowledge of local streams. DEP values the substantial contributions of its partners in supporting a cooperative approach to stream monitoring and protection.

III. Purpose & Methods For Rating Streams

FIGURE 3A. **Montgomery County Watersheds and Monitoring Sites**
(See center gatefold for larger version)



Biological Monitoring

DEP monitors fish and aquatic insects as a tool to assess and track the health of all county streams over time. DEP observes the changes that occur to the structure and function of the in-stream aquatic communities to assess how cumulative impacts of habitat change and pollution are affecting the stream. Biological monitoring results can be compared to stream habitat assessments to determine if the habitat condition is impairing the biological community, or if chemical pollutants and/or other factors are the causes.

Montgomery County's streams are primarily found in the piedmont region, located west of the Atlantic coastal plain and east of the Appalachian Mountains. Piedmont streams typically have moderate slopes and rock or bedrock bottoms. Following EPA guidelines, DEP developed *"Reference Conditions* g " to represent biological communities found in the county's highest quality, least impaired piedmont streams. This was accomplished by analyzing the composition of fish and aquatic insect communities collected at some forty reference stream sites, developing an *Index of Biological Integrity (IBI)* g from this data, and applying the IBI as the scientific basis to compare and rank conditions found in any county stream against Reference Conditions.

DEP conducts biological monitoring at approximately four hundred baseline monitoring stations, providing full coverage to all of the principal streams in the county and many tributary stream headwaters (Figure 3A). Data collection is a true community effort. Sources of biological data used in determining stream condition throughout Montgomery County include DEP, Maryland-National Capital Park and Planning Commission, State of Maryland (Department of Natural Resources-Maryland Biological Stream Survey (MBSS)), and a number of citizen volunteer groups.

IBI Measures and Usage

IBI's describe the biological community through the use of measures of community structure and function that respond, in a predictable way, to increased impairment from habitat or pollutant stressors. For example, as stream conditions degrade from pollution or habitat impairment, the number of species and/or the biological diversity of species inhabiting the stream will decrease and be reflected in a lowered IBI score.

Separate measures are applied to produce IBI's for both the fish and aquatic insect (benthic macroinvertebrate) communities (Table 3A). IBI

TABLE 3A. **Measurements used in the fish and benthic macroinvertebrate IBI's**

Fish IBI	Benthic macroinvertebrate IBI
Total number of species	Total number of taxa
Total number of riffle benthic insectivores	Biotic index
Total number of minnow species	Ratio of scrapers/scrapers + filtering collectors
Total number of intolerant species	Proportion of hydropsyche + cheumatopsyche/total EPT individuals
Proportion of tolerant individuals	Proportion of dominant taxa
Proportion of individuals as omnivore/generalist	Total number of EPT taxa
Proportion of individuals as pioneering species	Proportion of total EPT individuals
Total number of individuals (excluding tolerants)	Proportion of shredders
Proportion of individuals with disease/anomalies	

Fish sampling crew

Aquatic insect sampling

scores are then assigned, for fish and for aquatic insects. To arrive at one rating for a stream, the IBI scores for fish and for aquatic insects are averaged and assigned a narrative condition rating of "excellent, good, fair, or poor." These narrative ratings are derived from IBI scores representing the county's highest quality reference streams. For example, a stream rating of excellent means that organisms inhabiting a stream closely compare with those found in the top 50 percent of reference streams.

Stream Habitat

The quality of stream habitat is important in understanding probable causes of impaired biological condition. A visual assessment of stream habitat is performed when biological monitoring is undertaken.

Ten habitat quality measures developed by the EPA are used in the visual habitat assessment: *instream cover, epifaunal substrate, embeddedness, channel alteration, sediment deposition, riffle frequency, channel flow status, bank vegetative protection, bank stability,* and *riparian vegetative zone*. Each parameter is visually scored following written guidelines provided on the habitat assessment field form. All parameters are combined for an overall habitat rating (Barbour and Stribling, 1994).

Good stream habitat

Streams with good habitat have all the conditions necessary to support a healthy biological community including: 1) tree canopy to shade the stream and provide food in the form of leaf detritus for aquatic insects; 2) in-stream cover such as rocks, logs and undercut banks that provide protection for fish and aquatic insects; 3) little or no fine sediment covering the stream bottom; 4) gravel and cobble-sized stones with open spaces under and around them to harbor aquatic insects and aid in fish reproduction; 5) consistent patterns of shallow, fast areas or riffles and slow, deep areas, such as pools, throughout the stream's length; and 6) stable stream banks, well covered with a variety of vegetation which helps protect against excess stream channel erosion.

Poor stream habitat

Most streams with poor habitat are characterized by having: 1) an over accumulation of fine sediment in the stream channel that smothers the riffles and fills in the pools; 2) steep, erosion prone and unstable stream banks lacking vegetative cover, that; 3) erode and deposit into the stream channel, smothering much of the stream habitat; and 4) severely undercut stream banks, which topple shade trees, leading to rising stream temperatures, and reducing the availability of tree leaves as important food sources to the benthic aquatic community.

Causes of poor habitat conditions

The primary cause of poor stream habitat in this county is altered stream *hydrology*. Increases in stormwater runoff associated with watershed development have accelerated channel erosion, habitat loss, and sedimentation damages in county streams. These impacts started with the clearing of land more than three hundred years ago for timber and agricultural purposes. Stream channels continue to adjust to alterations in stream hydrology as watershed development has gradually shifted from agricultural to residential and commercial uses to accommodate the county's population growth.

Hard surfaces, impervious to water, such as roads, parking lots, and rooftops, cover an increasing proportion of the landscape. Additions in impervious surfaces and highly compacted lawn surfaces increase the volume of water that rapidly runs off into streams during storms. Less rainfall can naturally infiltrate into soils, which may lower the water table, reduce well yields, and limit replenishment of stream flows during dry weather periods. Before the mid-1980's, increases in impervious areas were not accompanied by stormwater controls to help mitigate the erosive effects of runoff. The combined effects of increased flooding, accelerated channel erosion, and reduced groundwater replenishment of stream flows can often devastate natural stream channel habitat and its ability to support a diverse biological community.

Sediment is the most important pollutant in Maryland. It has been estimated that up to seventy five percent of sediment deposits from developed urban and suburban areas are from accelerated stream channel erosion, rather than erosion from upland soils, as was traditionally thought. Eroded stream channel sediments may also carry attached *nutrient loadings* to impact local and downstream waters. Severe channel erosion can also expose and potentially damage sanitary sewers and other utility lines which can lead to catastrophic pollution and require extensive, costly repairs.

Other threatening impacts to stream habitat include trash, non-native invasive plants, encroachments on county parkland and conservation easements, and deer browsing of woody vegetation. Aquatic species and birds can ingest or become entangled in foreign substances found in garbage-strewn stream environments, endangering their health. If trash accumulations are not prevented and removed, neighbors may

A good stream habitat contains features such as a tree canopy, gravel and cobble-size stones, and stable stream banks.

Poor stream habitats have very steep banks which lack vegetative cover, which are vulnerable to erosion during high flow events.

begin to view this as a normal waterway condition and add to the abuse.

Some non-native plant species, accidentally introduced from other remote regions, are free of natural plant competition, insects, and diseases which would otherwise keep them in balance. Prolific seed production and rapid growth of invasive plants such as multiflora rose, porcelain berry, and thistle is gradually out-competing and overtaking desirable native species in some stream buffer areas. **www.mncppc.org**

Unauthorized encroachment upon publicly-owned parkland and conservation easements, usually by adjacent private property owners, is an illegal activity that can significantly damage streams and protective stream buffers. Encroachments can include mowing of protected stream buffer areas, removal of trees and shrubs which help to stabilize and shade streams, and the dumping of yard trim into the stream itself.

Another habitat problem affecting *riparian buffers* is excessive *deer browse* of vegetation such as saplings, shrubs, and low tree branches. Deer populations, unchecked by natural predation, will commonly eat newly sprouted trees, frequently killing them before they have a chance to sufficiently regenerate and sustain protective tree cover in riparian stream buffers and upland forests.

Identifying causes of impaired aquatic communities

Stream habitat quality largely determines the quality of the biological community, with good habitat supporting a healthy biological community, while poor stream habitat likely to support a poor biological community. When a poor biological community is found in a stream with good to excellent habitat, other factors must be impacting the biological community. These conditions can include altered stormwater and baseflows, *sediment deposition,* elevated water temperatures, and *chemical stressors* . When monitoring reveals inconsistencies between habitat conditions and expected biological communities, DEP conducts follow-up visual investigations and/or stream chemistry monitoring to assess any potential causes of the impairment. DEP is working to improve screening methods to help better identify and isolate non-habitat related stressors to the biological community. The ability to accurately identify stressors and defend the evidence supporting those findings is a critical step in developing strategies that will improve the quality of aquatic resources (Cormier, et al, 2000).

Measuring stream channel stability

Four of the ten collected measures of habitat quality (*embeddedness, sediment deposition, bank vegetative protection, and bank stability*) are used to evaluate stream channel stability. If a stream is deemed unstable based on these parameters, it is considered as a possible candidate project for stream restoration (see Section VII).

Embeddedness is a measure of how much streambed material, such as gravel or cobble, is surrounded by the silt, sand, or mud of the stream bottom. Generally, as rocks become more embedded, the surface area of habitat available to aquatic insects and fish for shelter, spawning, and egg incubation is decreased.

Sediment deposition measures changes to the stream bottom resulting from sediment accumulations. While some deposition is natural, large-scale movement of sediment, accelerated by excessive erosion, can bury rocky stream bottoms used as habitat by aquatic insects and as spawning areas by fish. High levels of sediment deposition and movement create an unstable and continually changing environment unsuitable for many organisms.

Stream bank vegetation estimates the percentage of the stream bank covered by native roots, trees, shrubs or other vegetation. The root systems of plants growing on stream banks help hold soil in place, thereby reducing the amount of erosion likely to occur. The overhanging vegetation serves as cover in the stream and helps cool the water temperature. Stream banks, well covered with natural plant growth provide far better habitat for aquatic species than banks lacking vegetation or stabilized with concrete embankments.

Stream bank stability measures the extent of or potential for excessive stream bank erosion. Steep banks are more likely to collapse and suffer from erosion than gently sloping banks and are generally more unstable. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil. (Barbour and Stribling, 1994)

Water chemistry

Readings of pH, dissolved oxygen (DO), conductivity, and temperature are taken at monitoring stations as a regular part of the stream monitoring program. These physical properties of water help in understanding the water quality of a stream at the time it is monitored.

pH is a measure of the acidity or alkalinity of water on a scale of 0-14. Lower pH readings are more acidic while higher readings are more alkaline. Rainfall is naturally slightly acidic with a pH of around five and one half due primarily to the interaction with carbon dioxide in the atmosphere. As rainfall flows over or infiltrates the land surface, county soils and geology buffer the acidity to the extent that in-stream concentrations of pH are typically between seven and seven and one half. Ninety-two percent of all pH readings taken in county streams during 1994 to 2000 were within Maryland water quality standards (COMAR 26.08.02.03-3) (Figure 3B).

Fish and aquatic insects require DO in water to breathe though their gills. Dissolved oxygen requirements vary between species. Some species, such as rainbow trout, blue ridge sculpin, stonefly, and mayfly, require higher concentrations of DO, while others, such as common carp, white sucker, worms, and crayfish, can tolerate lower DO. It is generally recognized that DO concentrations less then 5 mg/l (milligrams per liter) are stressful to aquatic life. Maryland's water quality standard for DO is set at 5 mg/l (COMAR 26.08.02.03-3).

Most of the DO readings taken in county streams range between eight and eleven mg/l. Ninety eight percent of readings were above the Maryland water quality criterion of five mg/l. (Figure 3C) (COMAR 26.08.02.03-3). However, monitored DO levels in some streams occasionally fell below five mg/l. The majority of these readings occurred during hot summer days when stream flow was also very low.

Summer water temperatures for most streams in the county average 75 degrees Fahrenheit (F). The physical properties of cool water are able to sustain higher levels of DO than warm water. Many resident species have tolerances to DO conditions that can only be supported by relatively cool water (75 degrees F or less). Some of the higher quality streams may stay at or below 68 degrees F throughout the summer. Cold water species, such as brown trout, require these average cooler temperatures and the higher DO levels they can sustain to survive.

Nutrients and water quality

Nutrients are substances necessary for life. The most common nutrients are nitrogen (N) and phosphorus (P), used for building cells and for energy. These two elements are the N and P listed on bags of plant fertilizers commonly used for lawns and landscaping. The most widespread source of nutrients in Maryland streams is excess fertilizer from farm fields and lawns (USEPA, 1999). Sanitary sewer overflows and septic tank discharges from urban and suburban sources can also be intermittent and regular sources of excessive nutrients. N and P discharges in treated wastewater effluent represent a regulated, but important source of *nutrient loading* inputs to streams.

In a diverse and high quality aquatic community, there is a balance between the amount of nutrients entering the water and the amount that is easily taken up by that community. When there are excess nutrients, eutrophication may occur, especially in slow moving waters. *Eutrophication* is a condition in an aquatic ecosystem where high *nutrient concentrations* stimulate blooms of algae, creating conditions that may interfere with the health and diversity of the overall biological community (MAIA, 2003). Eutrophic conditions typically occur during the warmer months of the year and can result in wide swings in the daily pattern of dissolved oxygen. Currently, there are no established water quality standards in Maryland for nutrients to protect aquatic resources, but there is a drinking water standard of 10 mg/l to protect human health.

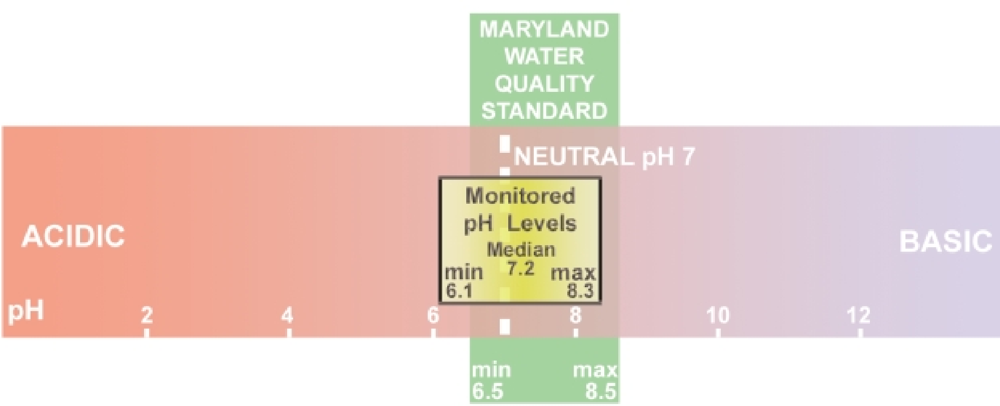
Nutrient monitoring results

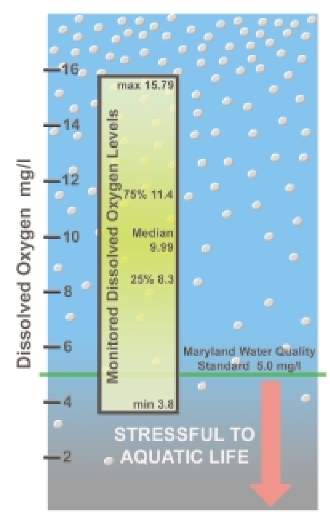
As part of its statewide stream sampling program, the MBSS monitors for nitrate-nitrogen (NO_3—the principal component of the N in plant fertilizers) (Kazyak, 2001). Based on 1994-1997 sampling, the MBSS reported an average of 2.38 mg/l NO_3 in the county, which gave it a ranking of eleventh among the twenty three jurisdictions in the state (MD DNR, 2001).

The MBSS monitored a number of stations in county streams for nitrate from 1994-97. DEP continued nitrate sampling at a select subset of stations during the spring of 1998 and 1999. The geographic distribution of MBSS and DEP nitrate sampling stations across the county is shown in Figure 3D. Table 3B summarizes results of this monitoring.

When compared to the MBSS data results, the smaller range in minimum and maximum nitrate concentrations shown in DEP's data may be reflective of DEP's shorter, two-year monitoring period. Over the four years of MBSS sampling, a broader range of values could be expected. The geographic distribution of MBSS stations was less representative of the county's developed watersheds than the DEP dataset.

No stations monitored in the county from 1994-1999 showed NO_3 values above the 10 mg/l drinking water standard. However, all indicate nitrate concentrations greater than the one mg/l





(LEFT) FIGURE 3B. 92% of 1,455 pH readings taken in Montgomery County streams during the period of 1994-2002, are within the Maryland water quality standards.

(RIGHT) FIGURE 3C. 98% of 1,463 dissolved oxygen readings taken in Montgomery County during the period of 1994-2000 are above the Maryland water quality standard of 5.0 mg/l

above which the MBSS suggests as representing unnaturally elevated levels of NO_3 (Boward et al, 1999). Interestingly, all but one of the lowest *and* highest observations in all three sets of monitoring data came from the Seneca Creek watershed. This seems to reflect the wide range of agricultural and developed lands in various parts of this watershed. The least developed agricultural lands generally showed higher *nutrient loads* than the more developed areas. Three wastewater treatment plants in the watershed (Damascus, Seneca, Poolesville) also contribute some nutrient loadings as allowed in their state-regulated effluent discharge permits. The town of Poolesville's discharge is of particular concern because the plant is presently operating in excess of its permitted flow capacity. Treatment plant upgrades are now planned to correct this problem.

The color coding in Figure 3D shows an increase in concentration as colors change from the blue symbols to green, yellow, and red. Consistently, lower values (blue and green markers) occurred in the more developed parts of the county, in the southern and eastern sections, while the highest values (greater than 3 mg/l, shown with a red marker) occurred in the western, more rural and agricultural sections of the county. This pattern has significant implications for targeting watershed management strategies for nutrients.

Although some rural county watersheds do show elevated *nutrient concentrations*, this does not necessarily have serious impacts on the local instream biological communities. This is because the relatively fast-flowing nature of most county streams can transport dissolved nutrients downstream quickly before harmful concentrations can occur. However, these elevated concentrations do contribute to *nutrient loading* problems that now impact the Potomac River, Patuxent Reservoirs, and the Chesapeake Bay.

FIGURE 3D.
Concentrations of Nitrate from Nutrient Monitoring Stations

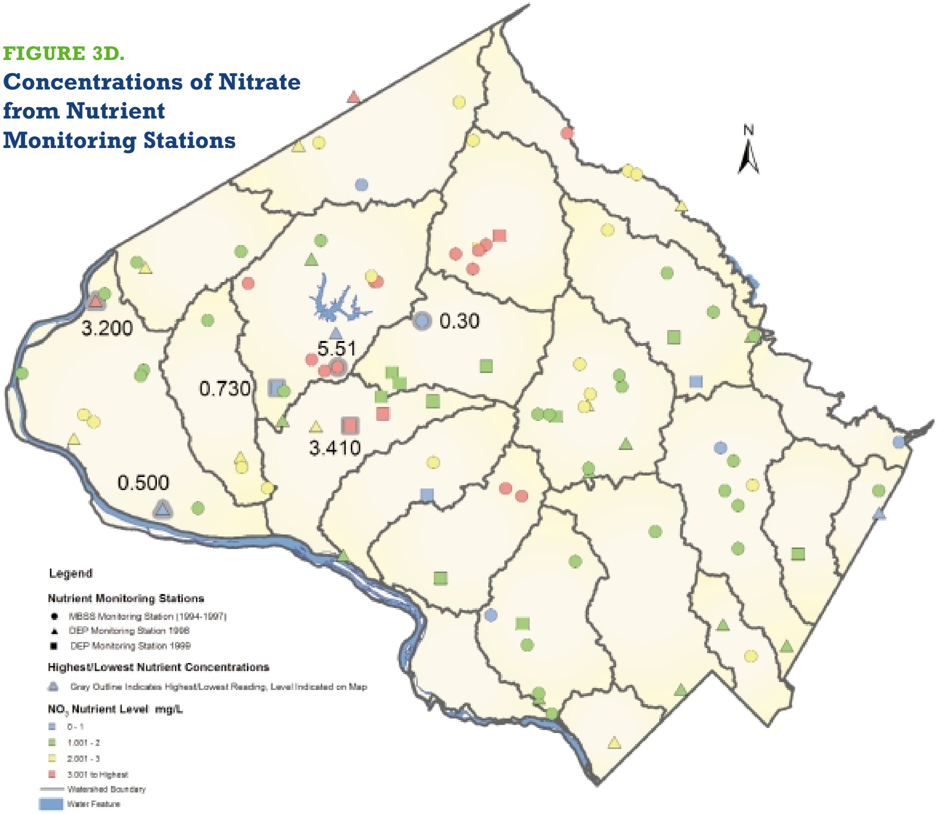


TABLE 3B. Nitrate (NO_3) nutrient concentrations in mg/l from 1994-1999

Program and Year	# of Stations	Average (mg/l NO_3)	Minimum to Maximum (mg/l NO_3)
MBSS 1994-1997	91	2.38	0.191 to 5.514
DEP 1998	32	1.94	0.050 to 3.2
DEP 1999	17	1.69	0.730 to 3.41

MBSS = Maryland Biological Stream Survey

DEP = Montgomery County Department of Environmental Protection

Bacterial contaminants

As in most urbanized areas across the country, data from various sources indicate that Montgomery County's streams regularly exceed the *fecal coliform* bacterial indicators used in Maryland water quality standards, especially following rainfall events. Extensive technical debate continues about the appropriateness of the fecal coliform bacterial test as a useful measure of bacterial contamination. This reflects both the ubiquitous nature of sources involved, particularly in runoff-borne nonpoint sources, and uncertainties about whether some of these sources represent significant threats to public health. Recent scientific studies indicate diverse sources of bacterial contaminants to county streams, including many from natural wildlife and bird populations, where control options appear limited. Another more manageable source is pet waste, particularly from developed watersheds. Point sources of obvious public health concern are fecal human waste, usually discharged from overloaded or leaking sewer lines, inadequately treated wastewater discharges, or malfunctioning septic systems. Historically, these sources have been of relatively low incidence in the county and usually are quickly rectified when found. DEP continues to work closely with state and local agencies to define the most appropriate steps and priorities for addressing manageable sources of bacterial contamination.

Other types of impacts

Other stressors that affect streams, the most severe of which are often found in urban areas of our county, include heavy metals from brake linings and thermometers, road salt, and pesticides. One example, in the 2000 summer, involved the illegal dumping of substantial amounts of bleach into the Turkey Branch of Rock Creek, which killed the majority of the fish in the tributary.

Additional stressors to the aquatic community are periodic sewage spills and leaks. There are generally more reports of sewage overflows and leaks in the older down-county areas, where aging sanitary sewer lines, servicing higher development densities, have greater maintenance needs. Smaller sewer lines are also affected by invasive tree roots and grease blockages.

IV. Stream Conditions: Current Status

Information on the current status of county stream conditions is based upon results from DEP's first completed monitoring cycle covering all county watersheds (1994-2000).

Average stream conditions by stream miles

Sixty-two percent of the monitored stream miles in the county are rated as "excellent" or "good" while 38 percent of the total stream miles are rated "fair" or "poor" (Table 4A). The 112 miles shown as not sampled include areas that are either too deep to monitor or involve streams that are intermittent or too small to be sampled. In addition, 114 miles of the Potomac River, Patuxent River, large lakes, and the C&O Canal are monitored by other agencies, such as Maryland Department of Natural Resources (MD-DNR), Washington Suburban Sanitary Commission (WSSC), and Maryland National Park and Planning Commission (M-NCPPC). DEP does not routinely sample these systems because of their size, depth, boat access requirements, and because these are already monitored for a wide variety of chemical parameters.

However, during the 2002 drought, DEP participated in habitat evaluations coordinated by Maryland DNR to re-assess the minimum low flow requirements now established for the Potomac River at Little Falls. This effort included monitoring, mapping, and assessing Potomac River habitat from Seneca Creek to the Little Falls Dam to review the adequacy of present minimum flow requirements which are in place to protect the biological integrity of the Potomac River. Specified minimum allowable Potomac River flow limits at Little Falls, restrict the maximum amount of river flow that can be withdrawn from the Washington Metropolitan Area's water supply intakes located immediately upstream between Seneca Creek and Little Falls.

Stream conditions by major watersheds

The 1998 CSPS presented information on stream conditions found in each of the major county watersheds. For some watersheds, stream ratings were termed "preliminary" because they lacked the complete suite of biological and habitat data used to evaluate conditions in most watersheds. This CSPS update replaces ratings on stream conditions in watersheds where ratings had been previously based upon preliminary data. Findings on stream conditions reflect results of DEP's completion of its first five-year monitoring cycle, in which all county watersheds were fully monitored at least one time over a five-year period. The update also reflects the results from sampling additional monitoring stations to improve full watershed coverage.

Figure 4A describes average stream conditions found within each of the county's 23 major watersheds. Average watershed condition ratings were based upon combining results of observed stream conditions from the smaller drainage areas to each of approximately 400 monitoring stations countywide (Figure 4B). Examination of the smaller, individual monitoring station drainage areas allows more in-depth examination of the varying conditions found in the county's major watersheds. These results can also be compared to the stream conditions described in the 1998 CSPS. **conditions.askdep.com**

Following is a summary of average watershed conditions, organized by the major watersheds shown on Figure 4A. Watershed summaries also refer to information on some of the more detailed monitoring results depicted on Figure 4B. The urban watersheds, with moderate to high density land uses, are discussed first, followed by the rural watersheds, which generally contain lower density residential or agricultural land uses. Within these two categories, the individual watershed summaries are presented in alphabetical order.

Urban watersheds

The majority of the major urban watersheds listed below had a "fair" stream condition rating. Down-county urban watersheds (generally represented as those inside of or near to the Capital Beltway and the lower end of the I-270 corridor) were the earliest to change from agricultural to urban/suburban land use because of their proximity to Washington, D.C. These watersheds tend to have higher percentages of impervious area, fewer acres controlled by stormwater management facilities, and many more miles of piped headwater streams, than county watersheds located to the north and west. These cumulative impacts altered stream base and storm flows, increased in-channel *sediment deposition* g, increased bank erosion, and lowered stream stability and habitat quality.

Cabin John Creek (Fair) is significantly impacted by suburban development centered around the county's main transportation corridors (CSPS, 1998). The headwaters and middle portion are in fair condition (Figure 4B). Booze Creek and Beltway Branch in the southeast and Snakeden Branch in the northwest remain in poor condition (Figure 4B). Three tributaries to the southwest (Buck Branch, Ken Branch, and the Congressional tributary) still support a healthy fish community and are in good condition (Figure 4B). Today, increased citizen awareness of the watershed had led to the formation of the Friends of Cabin John Creek Watershed. This volunteer citizen group is dedicated to the restoration, preservation and stewardship of the watershed.

Little Falls (Poor) watershed contains one of the county's most urban and altered stream systems. Stream conditions remain poor (Figure 4B), with little biological life or diversity above MacArthur Boulevard. Recently completed stream restoration projects in the areas below Massachusetts Avenue may enable successful reintroduction of some native fish and amphibians once resident in the watershed.

Little Paint Branch (Fair) The upper portions of Little Paint Branch remain in good condition (Figure 4B) and still provide habitat necessary to support healthy communities of fish and aquatic insects. Conditions decline rapidly downstream as many portions of the watershed were developed before requirements for stormwater controls.

Lower Great Seneca (Good) originates in the urban Gaithersburg area with poor and fair conditions, Lower Great Seneca improves to a good condition as it leaves the rapidly expanding urban development areas around Quince Orchard (Figure 4B).

Lower Patuxent River (Fair) watershed consists of the Patuxent mainstem and its tributaries below the Hawlings River (CSPS, 1998). Even though much of the land is protected by park land, buffers and master planning, only the upper portion supports good stream conditions ((Figure 4B). The lower half has a fair stream condition (Figure 4B).

Lower Rock Creek (Fair) is a heavily urbanized, densely populated watershed that developed many years before there were requirements for managing stormwater runoff resulting from development (CSPS, 1998). While it's overall condition is fair (Figure 4A), major portions of the upper watershed draining Rockville, and middle portions in the Kensington and Silver Spring areas are in poor stream condition (Figure 4B). A toxic chemical released into the creek near Connecticut Avenue in 2002 killed thousands of fish throughout the stream as far as the District.

Middle Great Seneca Creek (Fair) drains the urban areas of Gaithersburg, Montgomery Village, and parts of Germantown. Cabin Branch and Whetstone Run to the east of the watershed remain in fair condition. Gunners Branch on the southwest was rated in good condition despite relatively high imperviousness.

Muddy Branch (Fair) Headwaters of Muddy Branch are within Gaithersburg, with much of the middle portion outside of Gaithersburg being developed since 1973 (CSPS, 1998). The very headwaters are in poor stream condition with much of the middle portion of Muddy Branch in fair condition (Figure 4B). Portions of the Dufief Tributary and Quince Orchard Knolls Tributary remain in good condition. The lower third of the Muddy Branch is in good condition with the exception of the Farmlands Tributary which supported a fair condition.

Northwest Branch (Fair) is the largest of the three county contributing watersheds to the regional Anacostia watershed (CSPS, 1998). The upper third of the watershed contains a variety of steam conditions ranging from excellent (Upper Bryant's Nursery) to poor (portions of the Longmeade Tributary and the Left Fork) (Figure 4B). The rest of the watershed largely supports poor to fair stream conditions.

Paint Branch (Good) supports a unique county and regional resource—an urban coldwater fishery and wild brown trout population, surrounded by suburban development and located in close proximity to the nation's capital. The upper reaches (particularly Good Hope and Gum Springs) provide essential spawning/nursery habitat and cold clean water for young trout. Zoning, land use, and *Special Protection Area* requirements in place for the upper watershed, plus continuing stream buffer acquisition and stream restoration efforts are helping to mitigate development impacts on the stream resource. Monitoring results for this update finds that most of the upper portions of the watershed support good stream conditions. Below Randolph Road, stream conditions vary from fair to good (Figure 4B).

Rock Run (Fair) generally provides good habitat owing to forested stream valleys, however, the streams only support a poor to fair biological community (Figure 4B).

Sligo Creek (Poor) watershed has been the focus of intensive watershed restoration activities by the county. In 1990, degraded stream habitat in upper Sligo Creek was only able to support two native fish species. Capital projects were designed and built to restore lost stream habitat and overcome many of the impacts typically encountered in urban streams. Habitat improvements were followed with the reintroduction of eighteen long absent native fish species during the early 1990's, seven of which, monitoring results have shown, remain self-sustaining. This success enabled portions of Upper Sligo Creek to receive a "fair" water quality rating in the original CSPS. However the most sensitive species, blue ridge sculpin, apparently was unable to maintain a viable population after the 1999 drought. Although there is some uncertainty as to the sufficiency of the original stocking of this species, monitoring through 2000 classifies Sligo Creek just slightly falling below fair and into a poor rating. With the extensive habitat restoration and stormwater management controls, DEP is confident that Sligo Creek will again soon support a fair and improving fish community. Recently, a citizen watershed group has been formed; the goal of Friends of Sligo Creek is to see Sligo Creek become the best natural area possible. The successes documented thus far in restoring Sligo Creek are setting the standard for other urban watersheds in and beyond our county (CSPS 1998). The nature and status of continuing restoration and species reintroduction work on Sligo Creek is further described in Section VII.

Watts Branch (Fair) watershed, like many county watersheds, is influenced by the historic development patterns that saw the creation of towns and roads at high points in the landscape (CSPS, 1998). These high points were often at the top of watersheds. Today, Rockville occupies much of the headwaters of Watts Branch. Piney Branch is a designated Special Protection Area with areas planned for medium to high impervious development. Much of Watts Branch supports a fair stream condition. The upper Piney Branch supports a fair or poor stream condition. The areas with a good stream condition are in portions of the Sandy Branch, West Piney Branch, and lower main stem below Glen Road (Figure 4B). Conditions in the Piney Branch have greatly fluctuated over the last several years, droughts and other natural factors may have cumulatively impacted the watershed along with development related impacts. More time is required to determine whether the Piney Branch can again fully support good stream conditions once the temporary development impacts in the headwaters have ceased and the development sites have been fully stabilized with permanent stormwater infrastructure fully in place.

Rural Watersheds

Average conditions in the county's predominately rural watersheds, where there is generally more large tracts of forested parkland and agricultural land, had an overall "good" rating. Residential and commercial development is either of low density or has been built with more modern storm water controls, wider accompanying stream buffers, and with less exclusive dependence on piped storm drainage systems to convey storm flows. Impacts from agricultural developments are also seen in these watersheds. However, in general, impacts on habitat conditions are less severe than those seen in the county's older, higher density urban and suburban areas.

Bennett Creek (Good) contains two high quality watersheds (Figure 4A). Bennett Creek is a forested agricultural watershed supporting a healthy and diverse ecosystem. Little Bennett Creek (lower stream system on Figure 4A) is a high quality cold-water stream. Some flow and habitat problems limit the ability of Little Bennett to improve as a coldwater resource (CSPS, 1998). All of Little Bennett supported a good stream condition (Figure 4B). Many of the best streams remaining in the county are found within this watershed and make up a portion of the reference stream reaches used to determine the stream condition of other county streams.

Broad Run (Good) originates west of Poolesville and passes through a section of Montgomery County little changed in over one hundred years (CSPS, 1998). Most of the